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Systematic Review

A literature study of anemia among malaria cases reported in Indonesia, from west to east: a parasito-epidemiology perspective

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ABSTRACT

Severe malarial anemia (SMA) is a potentially fatal complication of malaria, a neglected parasitic tropical disease that still become a global health problem. It occurs predominantly in vulnerable groups in the community, especially children and pregnant women living in endemic areas, including Indonesia. The data on prevalence of SMA and its contributing factors are sparse and incomplete, so the aim of this simple literature study is to provide that data. The author doing the electronic literature searching on Indone's data concerning malaria related anemia and factors that might contribute or causing this complication. There are 37 studies found on this issue, from 2001 until 2019. All 37 studies reported that anemia that developed during the course of the disease (malaria) varies from asymptomatic to severe form. This study showed the condition of anemia related malaria in Indonesia, from 2001-2019. Malaria still a big parasito-epidemiology problem. Prevention by continuous health promotion and proper management of malaria should be conducted to eradicate malaria and its complication.

Keywords: Blood protozoan, *Plasmodium* spp, Transfusion, Comorbidities, Children, Pregnant women

INTRODUCTION

Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected female Anopheles mosquitoes. There are 5 species malaria in human: *Plasmodium vivax*, *P. falciparum*, *P. malariae*, *P. ovale* and *P. knowlesi*. Geographic distribution of this disease is unique, especially region close to the equator. Even though potentially lethal, actually, it is preventable and curable.¹⁻³

During 2018, a rough estimation counts 228 million cases of malaria worldwide. The estimated number of malaria related morbidity as many as 405 000 in 2018. Children, especially aged under 5 years are the most vulnerable group affected by malaria.^{1,2} Global malaria cases already reduced slowly, even though the rate of decline is not as

fast as expected.¹ Morbidity and mortality due to malaria in endemic countries, including some part of Indonesia, still found.² Children and pregnant women are among the most vulnerable group.^{3,4}

The majority of malarial infections to some extent are associated with various degree of anemia.⁵ Its severity relies upon two conditions patient-related properties (e.g., gender, age, innate and acquired resistance for people living in endemic areas, comorbid) and also parasite-specific characteristics (eg, species of malaria infected, adhesiveness to the smaller vessels, and drug-resistance phenotype).^{6,7} Anemia related malaria is capable of causing collateral, mild to even severe, morbidity and mortality, especially in vulnerable groups, e.g. children and pregnant women.⁸⁻¹⁰ The most severe form of anemia in malaria named severe malarial anemia (SMA).^{5,8} Comorbidities, e.g. helminthiasis, malnutrition, HIV,

tuberculosis etc made the problem become more complex to solve.^{11,12}

In Indonesia, due to its wide geographical coverage and the lack of documentation or publication, the study of malaria related anemia has somewhat typically under-reported, belatedly, rarely and not thoroughly; even though that the result still give an excellent information needed not just by the academics and the clinicians, but to even to tourism practitioner, because some of Indonesia's best tourism destination located in region considered to be malaria endemic.¹³⁻¹⁵ Publication on this topics could improve awareness and precaution.¹⁶ The primary aim of this literature study is to review the incidence of anemia among Indonesia's malaria patients published in the internet, their geographic location and its related factors stated in the published studies that might consider contributing to the occurrence of anemia.

METHODS

The author did the literature searching on the internet using popular search engine Google™, Yahoo™ and Google Scholar™. The phrase used were "Malaria Anemia Indonesia pdf", "Anemia pada Malaria di Indonesia pdf", "Kasus Anemia pada Malaria di Indonesia pdf", "Malarial Anemia in Indonesia pdf" and "Anemia among Malaria case in Indonesia pdf". combination the search term in *Bahasa Indonesia*/Indonesian language and in English were conducted.

This literature searching conducted from July 27th to August 2nd 2020. Potential article was sorted based on the type of the article which must be research article or original article, the title and content of the abstract and then saved for further analysis. Thorough and careful reading was done in order to make sure that the potential article actually revealed the incidence of anemia on their report. Factors that might contribute to the occurrence of anemia were also screened. A brief note when considered necessary was made on these findings and will be presented in the form of a summary table.

RESULTS

From hundreds of article collected, potential articles shorten into dozens and the final number of article which is assessed by the author personally are 37 articles. Out of these 37 studies, some conducted by bachelor degree students as their final thesis, and some were conducted by health professional that taking care the malaria (+) patient and some conducted by researcher from ministries of Health. Some studies, especially those conducted in Papua were collaboration study with foreign researcher.

All 37 studies about anemia related malaria showed us that the spectrum of anemia as a consequences of malaria took place since the very early phase of infection, even though the clinical manifestation may occur

gradually. From all these studies (n=37) most of the study design were cross sectional (36/97.29%). A study conducted by Taylor et al have a cohort/prospective study design. The number of the respondents also varies from just dozens (e.g. Masengi et al) to hundred of thousands, and in all studies entangle both gender.

Out of these 37 studies, the data on 13 studies (35.13%) come from the subject infant, baby, toddler, children or <18 years old individuals. There are 5 studies (13.51%) with the subject were pregnant women and even one of these studies observed the outcome to that pregnancies. Even though most of these studies conducted on more diverse population. Table 1 list the summary of the findings in 37 studies conducted in some endemic areas in Indonesia concerning malarial related anemia.

The number of studies conducted on hospitalized or outpatient from Primary health care facility or hospital are 25 (67.56%), while community or population-based studies as many as 12 (32.44%). Time of study ranging from 2001 conducted by Yusroh et al in Mandailing Natal, North Sumatera (western part of Indonesia) and the most recent study conducted by Patriani et al in Southern Papua (eastern part of Indonesia), last year (2019).

From those 37 articles, in brief can be classified due to the geographic distribution based on major big island of Indonesia, namely Sumatera, Jawa/Java, Kalimantan/Borneo, Sulawesi, Ambon, Nusa Tenggara and Papua. Article no. 1-5 published data from Sumatera, article no. 6 from Java, article no. 7-8 from Kalimantan/Borneo, article no. 8-17 from Sulawesi, article 18-19 from Ambon, article no. 20-27 from Nusa Tenggara, article no. 28-37 conducted in Papua. From all 5 big island, Papua contributes the highest in number of studies (10/37=27.02%).

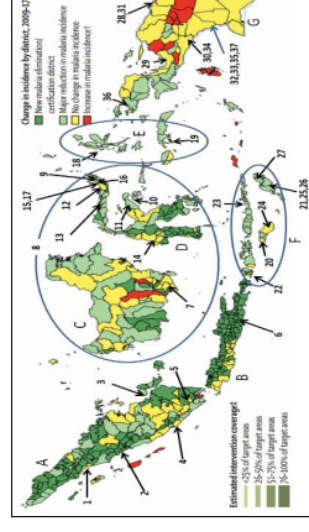


Figure 1: Recent map of malaria endemicity in Indonesia, 2018. We modified the map by adding arrow and number. Area pointed with arrow which studies conducted according to their sequence number listed in Tables 1, range from the year 2001-2019. (A-G) Are the big island in Indonesia, namely (A) Sumatera, (B) Jawa/Java, (C) Kalimantan/Borneo, (D) Sulawesi/Celebes, (E) Ambon islands, (F) Nusa Tenggara and (G) Papua, with modification.¹³

Table 1: Summary of the findings in 37 studies conducted in some endemic areas in Indonesia concerning malarial related anemia.

S. no.	Location	Author (year of publication)	Design of study, additional info on subject/location	Total no. investigated	Findings
1	Mandailing Natal, North Sumatera, Sumatera	Yusroh et al ¹⁷ (2001)	Cross sectional and primary health care based	67 children malaria (+), aged <15 years old	<i>P. vivax</i> 49/67 =73.13% mean Hb 10.41 g/dL
					<i>P. falciparum</i> 18/67=26.86% mean Hb 10.46 g/dL
					Malaria based on gender <ul style="list-style-type: none"> • Vivax Male 8/18=44.44%, Female 10/18=63.56% • Falciparum Male 29/49=59.18%, Female 40.81%
					All showed morphology of anemia haemolytic
2	Padang, West Sumatera, Sumatera	Rahma ¹⁸ (2018)	Cross sectional and hospital based	76 patient's malaria (+)	<i>P. vivax</i> 73/76=96.05%, <i>P. falciparum</i> 3.95%
					Gender: male 46 (60.53%), female 30 (39.47%) <ul style="list-style-type: none"> • Anemia 21/76=27.63% • Mild 12/21=57.14% • Moderate 8/21=38.09% • Severe 1/21=4.76%
					Anemia more prominent on female non pregnant patient
					Anemia 165/326=50.61%
3	West Bangka, Sumatera	Supriadi ¹⁹ (2018)	Cross sectional and primary health care based	326 patient's malaria positive	Gender of Malaria (+) with anemia (+) patient <ul style="list-style-type: none"> • Male 141/165= 85.45% • Female 24/165= 14.55%
					Anemia more prominent on male patient
					Anemia based on type of malaria <ul style="list-style-type: none"> • <i>P. vivax</i> 16/165=9.69% • <i>P. falciparum</i> 113/165=68.48% • Mixed infection 36/165=21.81%
					Microscopic findings 3/55=5.45% malaria (+)
4	Bengkulu, Sumatera	Flora ²⁰ (2013)	Cross sectional and primary health care based	55 pregnant women with history of malaria	All malaria (+) also suffer from anemia (+)
					Malaria (+) pregnant women <ul style="list-style-type: none"> • All suffer from anemia • All had low TIBC • All had Fe serum level from low to normal
					Mean Hb among malaria (+) with anemia (+) <ul style="list-style-type: none"> • Mild anemia 11.66 g/dl • Moderate 8.72 g/dl • Severe 5.25 g/dl
					Negative correlation between parasitemia and anemia
5	Pesawaran, Central Lampung, Sumatera	Triwahyuni ²¹ (2014)	Cross sectional primary health care based	40 patients of malaria (+)	

Continued.

S. no.	Location	Author (year of publication)	Design of study, additional info on subject/location	Total no. investigated	Findings
6	Pacitan, East Java	Mardianah ²² (2006)	Cross sectional elementary school based	62 children with clinical history of malaria	19/62=30.64% anemia (+) 29/62=46.77% experienced recent clinical malaria
7	Kab Tanah Bumbu, Kalimantan (Borneo)	Marlinae et al ²³ (2014)	Cross sectional and population based	30 pregnant womens	Mild anemia 8/22=26.7% among pregnant women who used insecticide-treated bed nets that lived in 2 endemic areas of malaria
8	Kalimantan (Borneo) and Sulawesi	Avrina et al ²⁴ (2011)	Cross sectional, primary health-patient care based	206 patients • Vivax (+) 87 • Falciparum (+) 119 • Mixed (+) 23	Mean Hb for P. vivax and P. falciparum 10g/dL Fever in malaria vivax 31/87=35.63%, malaria falciparum 63/119=52.94% Anemia (Hb<11g/dL) malaria vivax 66.3%, malaria falciparum 37.1%
9	North Minahasa, Sulawesi	Mongi et al ²⁵ (2014)	Cross sectional, primary health care-patient based	50 patients with clinical symptom of malaria	5/50=10% malaria (+) microscopically All malaria (+) suffer from anemia Statistically, positive correlation of malaria with anemia
10	Banggai, Central Sulawesi	Arsin et al ²⁶ (2009)	Cross sectional, primary health care-patient based	150 patients with clinical diagnosis of suspect Malaria	78/150=52% malaria (+) microscopically Sensitivity of Anemia 76.9% and specificity of Anemia 59.7%, accuracy rate 68.7% Statistically, Anemia is the most correlated clinical sign of malaria with the result of microscopic examination In attempt to diagnosis malaria clinically, shivering and clinical anemia are the best predictor
11	Luwuk, Banggai, Central Sulawesi	Bantoyot et al ²⁷ (2011-2013)	Cross sectional, hospital-patient based	75 malaria (+) children <15 years old	Male 40/75=53.3%, Female 35/75=46.7% Aged 1-4 years old 26/75=34.7% Anemia 43/75=57.3% Type of malaria • Vivax 49/75=65.3% • Falciparum 13/75=17.3% • Clinical malaria 13/75=17.3%
12	Bolaang Mongondow, North Sulawesi	Lasari et al ²⁸ (2013)	Cross sectional elementary school based	110 students	9/110=8.18% Malaria (+) microscopically 7/9=77.77% malaria (+) were also anemia (+)
13	East Sumalata, Gorontalo, Sulawesi	Amalia ²⁹ (2017)	Cross sectional elementary school based	105, children age 7-12 years old	79/105=75.2% malaria (+) microscopically, male 49 (62%), female 30 (38%); age 7-9: 17 (21.5%) and age 10-12: 62 (78.5%) 59/79=74.7% malaria (+) were suffer from anemia (mean Hb 10.6 g/dL) 60/314=19.1% had history of Malaria
14	Kab. Mamuju, West Sulawesi	Ansar et al ³⁰ (2014)	Cross sectional, combination of both survey and Hb examination	314, teenage girl	94/314=29.9% anemia 27/60=45.1% who had history of malaria suffer from anemia

Continued.

S. no.	Location	Author (year of publication)	Design of study, additional info on subject/location	Total no. investigated	Findings
15	Manado, North Sulawesi	Halim et al ³¹ (2006)	Retrospective cross sectional, hospital-based 2000-2003	148 (+) severe malaria falciparum	Age between 1 month-13 years old 75/148= 50.67% Male, 73/148=49.32% female 30/148=20.27% also suffer from anemia
16	Tomohon, North Sulawesi	Paendong et al ³² (2016)	Retrospective cross sectional, hospital-based, 2011-2015	92 children age 0-18 years old	58/92=63% malaria falciparum, 18/92=37% malaria vivax Age 5-9 years 29/92=31.5% Gender: 61/92=66% male, 31/92=34% female Anemia: 1/92=1.1% suffer from anemia (+)
17	Manado, Tondano, North Sulawesi	Masengi et al ³³ (2019)	Retrospective cross sectional, hospital-patient (pregnant women) based on data of 2013-2018	11 pregnant women malaria (+)	Prevalence • 6/11=55% malaria tertian/vivax (+) • 5/11=45% malaria tropika/falciparum (+) Complication: 2/6=33% pregnancy related malaria tertian/vivax ended with prematurity, 1/6=16.66% pregnancy related malaria tertian/vivax ended with asphyxia Anemia • 2/6=33% malaria tertian/vivax • 2/5=40% malaria tropika/falciparum
18	Ternate, Ambon	Afiah ³⁴ (2019)	Retrospective cross sectional, hospital-based data	61 malaria (+) patient	Gender • 35/61= 52.9% male • 26/61= 47.1% Female Mean Hb for all samples: 10.34 g/dL
19	Ambon, Ambon Islands	Wabula et al ³⁵ (2019)	Retrospective cross sectional, population based	83 pregnant women on the 3rd semester	19/83=22.89% pregnant women suffer from anemia due to malaria or malaria infection that can caused anemia 20.2
20	West Sumba, Nusa Tenggara timur	De mast et al ³⁶ (2010)	Cross sectional	1197 Indonesian school children, aged 5-15 years	73/1197= 6.1% had asymptomatic P. falciparum with mean Hb 12.62 g/dL and 18/1197=1.5% asymptomatic P. vivax parasitemia with mean Hb 12.2 g/dL Antimalarial medication improves Hb in both groups
21	Timor Tengah Selatan, Nusa Tenggara Timur	Panjaitan et al ³⁷ (2019)	Case control of 181 malaria (+) vs 181 malaria (-), primary health care based	362 individuals	64/181=35.4% were suffer from anemia male 78/181=43.1% , female 103/181=56.9% Age: <40 66/181=36.46%, ≥40 115/181=63.53% No significant correlation between Malaria and Hb
22	Central Lombok, Nusa Tenggara Barat	Susilawati et al ³⁸ (2013)	Case control and primary health care	20 malaria vivax (+), 20 malaria falciparum (+), 20 control malaria (-)	Mean Hb • Malaria falciparum 10.5g/dl • Malaria vivax 12.2g/dl Mean density of parasite is higher in falciparum group

S. no.	Location	Author (year of publication)	Design of study, additional info on subject/location	Total no. investigated	Findings
23	Maumere, Nusa Tenggara Timur	Fitri et al ³⁹ (2014)	Cross sectional and hospital based	112 pair mother-infants, 92 evaluated for further analysis	Prevalence of congenital malaria in the endemic area 39/92=42.39% malaria (+), asymptomatic 21/39=53.84% malaria (+) suffer from anemia and 20/39=51.28% malaria (+) asymptomatic were looks ill Only anemia correlated significantly with malaria Male 123/262=46.9%, Female=139/262=53.1%
24	East Sumba, Nusa Tenggara Timur	Irawan et al ⁴⁰ (2017)	Cross sectional hospital based	262 hospitalized malaria (+) patient	Age >15 years old 143/262=54.58% Malaria falciparum 210/262=80.15%, malaria vivax 52/262=19.84% Mean Hb: malaria falciparum 11.0 g/dL, malaria vivax 10.84 g/dL
25	Timor Tengah Selatan	Hutagalung et al ⁴¹ (2016)	Cross sectional, systematic random sampling and community based	555 healthy individual, aged >14 years, using nested PCR	Total 181/555=32.61% malaria (+), malaria falciparum 57/181=31.49%, malaria vivax 94/181=51.93% and mixed infection 30/181=16.57% Anemia (Hb≤10g/dL) malaria falciparum 34/57=59.64%, malaria vivax 58/94=61.7% and mixed infection 20/30=66.66% Malaria vivax 95/152=62.5%, Malaria falciparum 57/152=37.5%
26	Timor Tengah Selatan	Nugraha et al ⁴² (2020)	cross-sectional study using secondary data in 2013-2014 from 5 sub-districts in South Central Timor Regency	152 malaria (+) individual	Anemia (Hb ≤11.23 g/dL) 75/152=49.34%, mean Hb vivax 43/75=57.33%, mean Hb 11.29 g/dl, falciparum 42.66% and mean Hb 11.13g/dL Mean Hb in falciparum group is lower than in vivax
27	Atambua, Nusa Tenggara Timur	Junarli et al ⁴³ (2017)	Cross sectional, hospital based September 2013 to February 2014	71 malaria tropical /malaria falciparum (+) individual	Gender: male 35/71=49.29%, Female 36/71=50.70% Febris (37.50-400C) 46/71= 64.78% Anemia 25/71=35.21%, mean Hb 11.65g/dl mild (8-11g/dl) 18/25=72%, moderate (6-8g/dL) 5/25=20% and severe (<6g/dL) 2/25=8% abnormal Hb level 80/160=50%
28	Jayapura, Papua	Palit et al ⁴⁴ (2019)	Cross sectional, secondary hospital data based and regression modelling	160 malaria (+)	abnormal Hb level at the age ≥40 75/80=93.75%, and < 40 5/80=6.25% Variables that contributes to anemia age, gender, nutritional status and age is the most significant anemia 39/45=86.66%
29	Nabire, Papua	Taati ⁴⁵ (2013)	Cross sectional, primary health care-based patient	45 toddlers	Malaria (+) 25/45=55.55% All malaria (+) also suffer from anemia malaria vivax 47/533=8.8% malaria falciparum 21/533= 3.9%
30	Mimika, Timika, Papua	Burdam et al ⁴⁶ (2016)	Cross sectional, households based asymptomatic children	533 blood film collected	5/269=39.03% soil transmitted helminth/STH (+) Those with STH (+) were at significantly greater risk of suffer from <i>P. vivax</i> parasitemia Anaemia (Hb<10 g/dl) was present in 24.5% (122/497) of children and associated with <i>P. vivax</i> parasitemia, <i>P. falciparum</i> parasitemia, hookworm carriage, <i>Plasmodium helminth</i> co-infection and severe stunting.

Continued.

S. no.	Location	Author (year of publication)	Design of study, additional info on subject/location	Total no. investigated	Findings
31	Jayapura, Northeast Papua and Papua	Taylor et al ⁴⁷ (2013)	Cross sectional combined with/ followed prospectively at day 0, 3, 7 and 28	n=57 indigenous Papuan and 105 non-Papuan with limited malaria exposure, treated with chloroquine, doxycycline or both for acute non complicated malaria vivax (n=64) and malaria falciparum (n=98)	Mean initial Hb 12.7g/dL (similar in both group), even though in vivax group, the Papuan group had lower baseline HB compared to the non-Papuan group Hb recovery related to baseline Hb Vivax infected malaria immune Papuan had persistently lower Hb concentrations compared to non-Papuan with limited malaria exposure
32	Southern Papua, Papua	Douglas et al ⁴⁸ (2013)	Cross sectional, referral hospital secondary data of laboratory and clinical data from April 2004 to December 2012	219, 845 Hb measured	malaria falciparum: 89,748 clinical events, 44, 171 patients malaria vivax: 54, 495 clinical events, 28, 841 patients mixed: 19, 569 clinical events from 14, 206 patients Anemia <ul style="list-style-type: none"> Mild (<10 g/ dl): 97,665/219,845=44.4% Moderate (7-10 g/dl): 27,106/219,845=12.3% Severe (<5g/dL): 8,151/219,845=3.7% Mixed infections were at the greatest risk of severe anemia
33	Southern Papua, Papua	Kenangalem et al ⁴⁹ (2016)	1 A three-stage, cross-sectional, community survey to determine the proportion of 1 anemia severity (Hb <7 g/dl) attributable to patent <i>P. vivax</i> , <i>P. falciparum</i> and mixed parasitemia in Papua, Indonesia	3890 blood sample	Malaria type <ul style="list-style-type: none"> Falciparum: 315 (8.1%) Vivax: 250 (6.4%) Mixed: 72 (1.9%) Mean reduction in hemoglobin <ul style="list-style-type: none"> Malaria falciparum: 1.16 g/dl Malaria vivax: 0.66 g/dl 1 Mixed: 1.25 g/dl Hb concentrations <7 g/dl in the community were estimated to be 1 attributable to patent parasitemia <i>Plasmodium vivax</i> was associated with a greater than three-fold higher attributable fraction of anaemia in infants compared with <i>P. falciparum</i>
34	Mimika district, South-Central Papua, Papua	Lampah et al ⁵⁰ (2015)	Cross sectional, hospital based, data mainly focus on platelet count measurements (Hb included) were available in 1 5,479 patients, 66,421 (30.8%) of whom had clinical malaria	215,479 patients	7931/215 044=3.68% had severe anemia 1484/7931=18.7% had the risk of severe thrombocytopenia among patients with severe anemia The overall adjusted population fraction of severe thrombocytopenia attributable to <i>P. falciparum</i> infection was 35.9%, <i>P. vivax</i> was 9.1% and mixed infections was 7.0% Severe anemia is an important prognostic indicator of fatal outcome, particularly in young children

Continued.

S. no.	Location	Author (year of publication)	Design of study, additional info on subject/location	Total no. investigated	Findings
35	Southern Papua, Papua	Patriani et al ⁵¹ (2019)	Cross sectional, hospital-based data on children presenting with malaria (April 2004 to December 2013)	15,716 children	<p>Prevalence</p> <ul style="list-style-type: none"> • <i>P. falciparum</i> 6184/15,716=39.3% • <i>P. vivax</i> 7499/15,716=47.7% • <i>P. malariae</i> 203/15,716=1.3% • <i>P. ovale</i> 3/15,716=0.00019% <p>5 Mixed infections 1827 (11.6%)</p> <p>5 within 1 year, 48.4% (7620/15,716) of children represented a total of 5,957 times with malaria (range 1 to 11 episodes)</p> <p>5 the incidence of malaria being greater in patients initially presenting with <i>P. vivax</i> group</p> <p>Mortality after initial presentation 266/15,716=1.7% w 5 in 1 year, 129/15,716=0.82% within 30 days. 137/15,716=0.87% between 31 and 365 days, no significant difference in the mortality risk in patients infected with <i>P. vivax</i> versus <i>P. falciparum</i> either before 30 days or between 3 5 and 365 days</p> <p>children <5 years with malaria vivax are at significant risk of multiple episodes of malaria and of dying within 1 year of their initial presentation</p>
36	Southern Sorong Papua	Abdussalam et al ⁵² (2016)	Cross sectional hospitalized and out patients	45 children	<p>Gender: 25/45=55.45 boys, 20/40=44.45% girls, 24/45=53.3% affected were between 1-5 years old. 30/45=66.7% malaria falciparum/tropical (+), 25/45= 55.6% anemia (+), Hb ranging 8-10 gram/dl and 19/45= 42.2% Wasting, 16/45=35.6% stunting</p>
37	Southern Papua, Papua	Poespoprodjo et al ⁵³ (2009)	1 Cross sectional To define malaria morbidity in the first year of life in an area where both multidrug-resistant <i>P. falciparum</i> and <i>P. vivax</i> are highly prevalent, data of all infants attending a referral hospital in Papua, Indonesia	4976 infants hospitalized	<p>1560/4976=31.35% malaria (+) 102/187=56% had malaria vivax, and 55/187=29.41% had n 1 malaria falciparum infection equally attributable to both types of malaria. The case-fatality rate was similar for inpatients with malaria falciparum (13/599=2.2% inpatients died) and malaria vivax (6/603=1.0% died) severe malarial anemia was n 1 re prevalent in malaria vivax (193/605=32% v 1 44/601=24%) and that was associated with a greater risk of anemia. In these young infants, infection with <i>P. vivax</i> was associated with a greater risk of severe anemia and severe thrombocytopenia compared to malaria falciparum.</p>

Anemia caused by malaria reported in these studies also varies, from mild anemia with minimal subjective complaint from the patients to the severe form of anemia that can endangered the live of the patient.

DISCUSSION

Severe malarial anemia (SMA) surely marks concern as a major public health problem because of the burdens of the affected children and also pregnant women.^{9,10} It is possibly that these numbers may escalate as the consequences of several reasons, e.g. difficulty in making correct diagnosis, drug unavailability, potency of drug resistance phylogeny spreads, limitation of medical devices, remoteness of an area that making the health personal difficult to transfer/refer patient and possible comorbidities. If we look back to the Figure 1, Indonesia is an archipelago consists of 13.600+ islands, with a very wide area and different topographic condition. The remoteness of an area, especially if that area is malaria endemic, is going to complicate the patient management, e.g. in case the doctors want to refer the patient to a more advanced health care facility.

Concerns have also been raised by data from recent epidemiological studies, which reported this severity related to other comorbidities. Malaria and anemia, both also increase the host's susceptibility to other secondary infection.^{11,12} Even¹⁰ such people living in endemic areas that already have acquired protection from acute infection, they still may succumb to severe anemia during a subacute or chronic phase of infection.^{1,15} Transfusing blood into such patient and managing them collectively and supportively also a very big challenge.¹²

The availability of electronic data on anemia related malaria in Indonesia is still sparse and detached. A more holistic surveillance needed with emphasize on its comorbidities, vulnerable groups, anti-malaria treatment given and how well the patient recover.

Fatality or mortality due to severe malaria anemia should have prevented earlier.¹ By making correct diagnosis as soon as possible and then start prompt treatment, complication⁵ can be avoid.⁸⁻¹⁰ In a community perspective, preventing recurrent malaria must⁴ a public health priority in this vulnerable population.⁵¹ Preventive strategies, early diagnosis, and prompt treatment should be initiated in the correct time appropriately by all stake holder.¹ By actively reducing the number of cases seems to be easier than sustained elimination.² All of this effort if conducted simultaneously can paved the way for malaria eradication.¹²

CONCLUSION

This brief literature study has revealed the condition of anemia related malaria from cases reported in Indonesia from 2001-2019. Eventhough many achievement have been done so far, these studies also informed us that

malaria still a big parasito-epidemiology problem in Indonesia. Prevention of transmission and proper management of malaria needed in order to avoid worse case scenario of severe malaria and its complication.

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